



ثانوية التكنولوجيا التطبيقية  
Applied Technology High School

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## Robotics II

### Module 1: Introduction to Data & Advanced Programming Blocks

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**Academic Services Unit**

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# Module 1: Introduction to Data & Advanced Programming Blocks

## Module Objectives

Upon successful completion of this module, students should be able to:

- Identify the programming palettes on the NXT software interface.
- Explain the function of data and advanced block commands
- Use the NXT software to program simple tasks using data and advanced block commands

## Module Contents:

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## 1.1 Introduction

Welcome again to the world of robotics. For more than 100 years, people have thought, dreamt, and written about robots. Robots perform a wide variety of important jobs. For example, robots explore other planets, investigate deep-sea volcanoes, assemble automobiles, and perform surgery. Figure 1.1 shows examples of robots that were built to improve our life at the World Robotic Olympic 2011 (WRO 2011).



(a) Home Security Robot



(b) Medicine Dispenser Robot



(c) Minesweeper



(d) Smart Cane

Figure 1.1: Sample robots from WRO 2011

In this module, you will review the programming blocks on the NXT Software especially data and advanced blocks. Then, you will use them to program basic tasks.








## 1.2 Review of Programming Palettes

As you studied in Robotics I, Lego Mindstorms NXT Software has three programming palettes which are:

1. **Common Palette:** has the most commonly used blocks, giving you quick access to the blocks that you'll use most frequently.
2. **Complete Palette:** includes all the available blocks, including the ones on the Common Palette
3. **Custom Palette:** includes blocks that you create or downloaded from the Internet

Try to test your memory by completing the following class activities.

### Activity 1: Complete the following table:

Block Icon	Block Name	Function
		
		
		
		
		
		
		

**Activity 2: Identify the programming blocks that are used to perform the following tasks.**

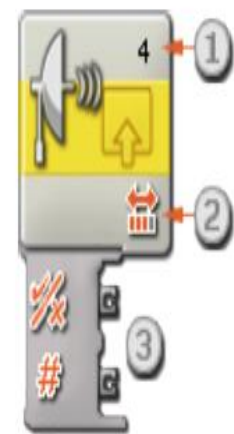
No.	Task	Programming Block/s
1	Record the physical motion of the robot	
2	Display the final score of a pinball game on the NXT Screen	
3	Play a sound file when the a train reaches its final destination	
4	Identify the presence of an obstacle before hitting it	
5	Repeat the machine operation five times	
6	Select between different options	

**Activity 3: In a certain robot application, the programmer used the following configuration for the given block. Fill the missing information for each block.**

1. The block shown is a \_\_\_\_\_
2. The block can be found under \_\_\_\_\_ palette.
3. The block is used to \_\_\_\_\_

The numbers 1, 2 & 3 in the figure indicate:

Number1:	
Number2:	
Number3:	



### 1.3 Data Programming Blocks

Data Programming Blocks are used to set up Boolean logic, random conditions, ranges and threshold for sensors, logical comparisons, creating variables and constants. Figure 1.2 shows various data blocks.

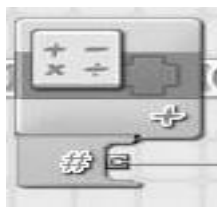


Figure 1.2: Data Blocks

Each Data block is described in details below:



- **Logic Block:** The Logic Block lets you combine multiple conditions, allowing your program to make more complex decisions. This lets your program ask questions like "Is the Touch Sensor pressed and the Light Sensor reading greater than 50?"



- **Math Block:** The Math Block is used to perform any calculation your program needs. You can use the math block to calculate the distance your robot is moving and the total score for a basketball machine.



- **Compare Block:** The Compare Block allows you to compare any two numbers, giving you more flexibility than using a Switch or Loop block alone. For example, you can compare the readings from two Rotation Sensors. You can then use the result of the comparison to control a Switch or Loop block.



- **Range Block:** The Range Block determines whether a number is inside or outside a range of numbers. There are two questions you can ask using the Range block: “Is the test value inside the range (between the lower and upper limits)?” and “Is the test value outside the range (less than the lower limit or greater than the upper limit)?”



- **Random Block:** The Random Block is used to generate a random number. You can use this block to create robotic games or to add some randomness to your robot’s behavior. Often a robot that is a little unpredictable can be more interesting or seem to have more personality



- **Variable Block:** The variable Block stores and retrieves variable values. You can save sensor readings in a variable and then update them after performing mathematical values.



- **Constant Block:** Constant Block is used to access constants in your program. This block looks like the Variable block, with a lock added to show that the value cannot be changed.

## 1.4 Advanced Programming Blocks

Advanced Programming Blocks are used to add text, convert data to text, control the sleep function of the NXT, save files on the NXT, calibrate sensors, and reset motors. Figure 1.3 shows various advanced blocks.



Figure 1.3: Advanced blocks

Each advanced block is described in details below:



- **Number to Text Block:** The Number to Text Block converts a number to its equivalent text data. You can use this block to convert the sensor readings to a text that can then be displayed on the NXT screen.



- **Text Block:** The Text Block lets you join together up to three pieces of text, which can be useful for adding labels to values you display on the NXT's screen.



- **Keep Alive Block:** The Keep Alive Block lets you prevent the NXT from turning itself off. The icon for this block is a pair of Zs (to indicate sleeping) crossed out using a red circle with a line through it. Having the NXT go to sleep is useful for saving your batteries; however, you may want to prevent the NXT from turning off while your program is running. That's where the Keep Alive block comes in.





- **File Access Block:** The File Access Block allows you to create your own files on the NXT, which you can use to store any data that your programs use. The information you store in a file is **persistent**, meaning that it's still available after your program ends, even if you turn off the NXT.



- **Calibrate Block:** The Calibrate Block is used to calibrate light and sound sensors by adjusting the minimum and maximum values of the sensor.



- **Reset Motors:** The Reset Motor Block resets the adjustment value of the motor to zero

## 1.5 Lab Activity 1

### Objective:

- Understand the use of the Number to Text Block
- Understand the use of the Text Block
- View the light sensor values on the NXT Screen.

### Material (per group):

1. One NXT Brick
2. One USB Cable
3. One light sensor

### Procedure:

1. Connect the light sensor to port 3 on the NXT brick.
2. Connect your NXT Brick to your PC using the USB cable.
3. Turn the NXT brick ON.
4. Create a new program and name it **readlight**
5. Write NXT-G program as shown in Figure 1.4

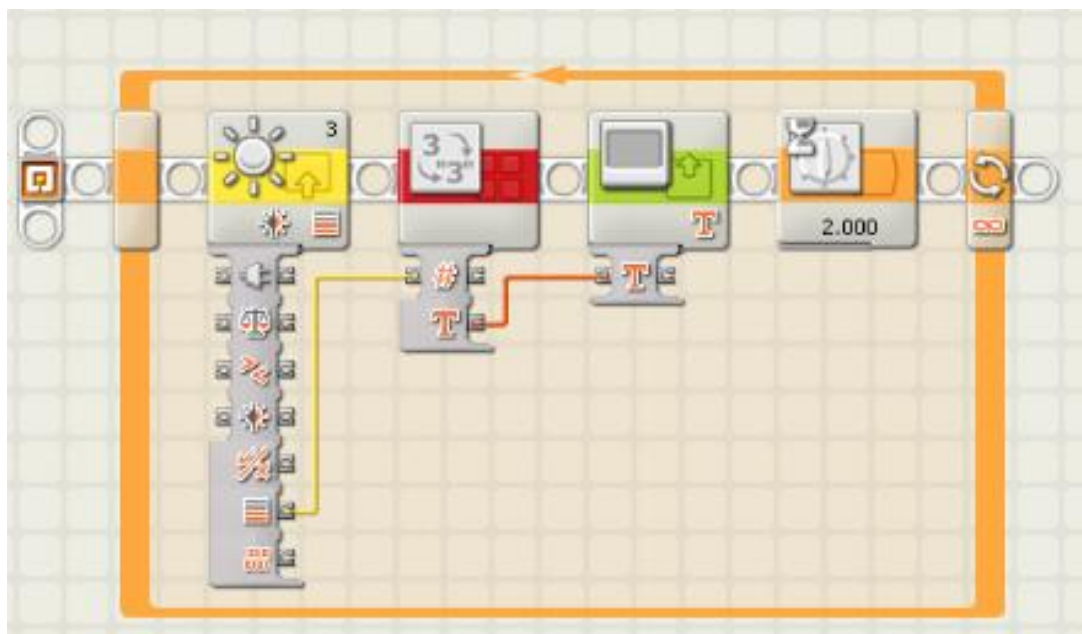


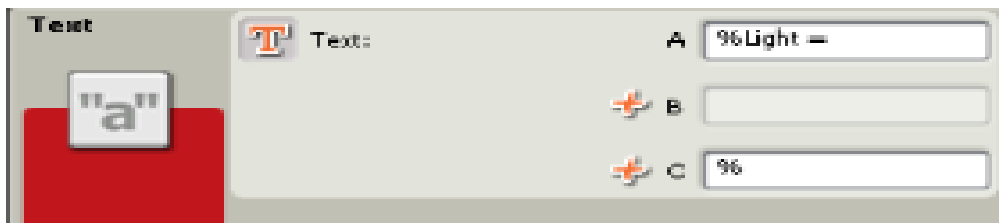
Figure 1.4: Light Meter Code 1

6. Download and run your program.

7. Pass the light sensor over different colors and record the values displayed on the NXT Screen. Record your values in the table below:

Color	Light Sensor Value
White	
Red	
Blue	
Block	

8. Add a Text Block between the Number to Text Block and the Display Block. Configure the Text Block as follows:



9. Your program should look like the one shown in Figure 1.5

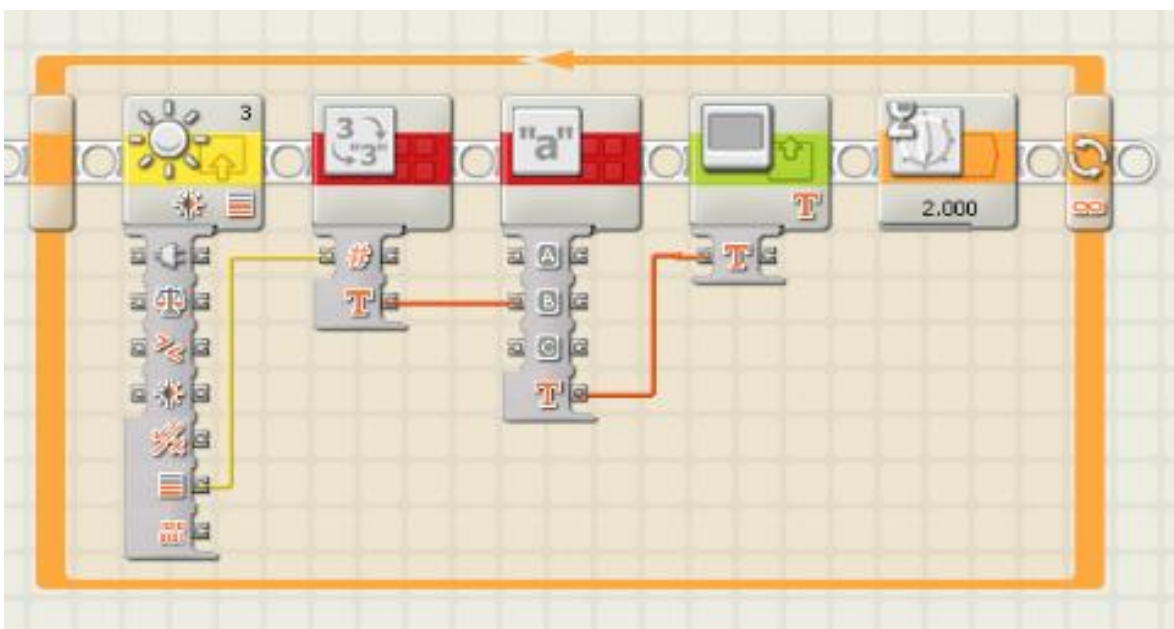


Figure 1.5: Light Meter Code 2

10. Download and run your program.

11. Pass the light sensor over different colors. What is the difference between the first and the second program?

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**Questions:**

- **Suggest an application of the NXT-G code shown in Figure 1.5.**

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- **How can you modify the previous program to implement a sound meter?**

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- **Explain the sequence of the NXT-G code shown in Figure 1.5.**

1. 

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2. 

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3. 

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4. 

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5. 

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6. 

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- **Identify the programming blocks that are used in Figure 1.5**

Programmming Block Name	Function	Programming Palette

## 1.6 Lab Activity 2

### Objective:

- Understand the use of Compare Blocks
- Use a Compare Block to control a switch

### Material (per group):

1. One Explorer Robot (See Appendix 1)
2. One USB Cable

### Background Information:

Compare Block can be found in the Data group of the Complete Palette (shown in Figure 1.6) and will appear in your program as shown in Figure 1.7. You can supply the two input values using data wires or the Configuration Panel (shown in Figure 1.8). The comparison is made based on the operation selected, which can be either "Less than", "Greater than", or "Equals". The result of the comparison is written to an output data plug.



Figure 1.6: The compare block on the complete palette



Figure 1.7: The Compare Block

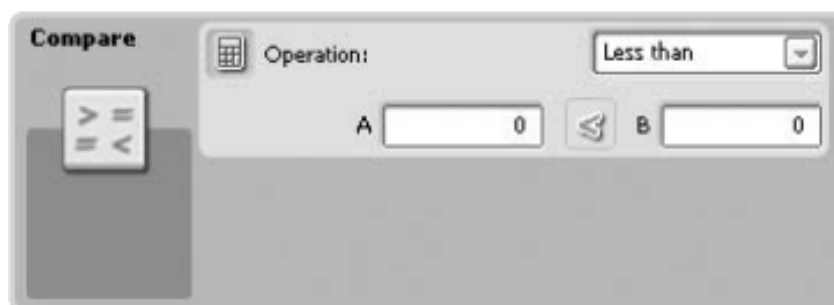


Figure 1.8: The Compare Block Configuration Panel

In this lab activity, you will use the Compare Block to compare between the ultrasonic sensor values of the explorer robot from the right and left sides respectively. Then, the result of the Compare Block will control the movement of the robot. If the distance from the left side is less than that of the right side, the robot will turn right to avoid obstacles and vice versa.

**Procedure:**

Use the explorer robot to perform the following task (building instructions can be found in Appendix 1)

1. Connect the ultrasonic sensor to port 4 on the NXT brick and the motor attached with it to port A.
2. Connect the other motors to ports B and C.
3. Connect your NXT brick to your PC using the USB cable.
4. Turn the NXT brick ON.
5. Create a new program and name it **CompareFunction**
6. Write NXT-G program as show in Figure 1.9

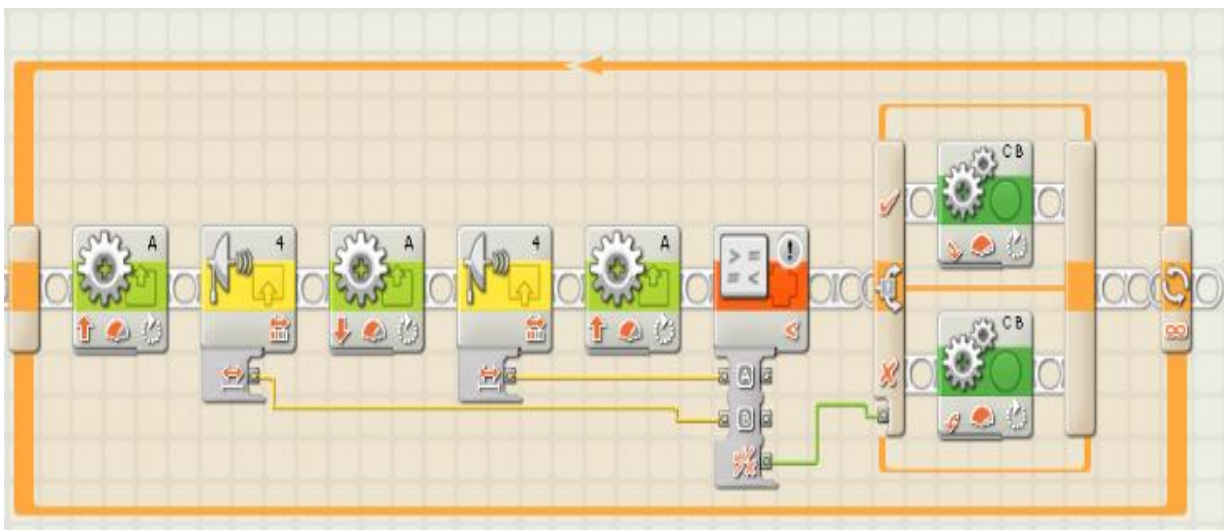


Figure 1.9: Compare Block Switch Control

## 7. Configure the programming blocks as follow:

- The first motor block:
  - Port: A
  - Direction: Forward
  - Duration: 90 degree
  - Power: 75



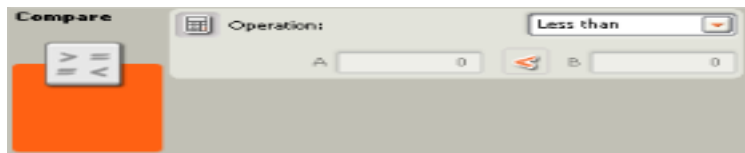
- The second motor block:
  - Port: A
  - Direction: Backward
  - Duration: 180 degree
  - Power: 75



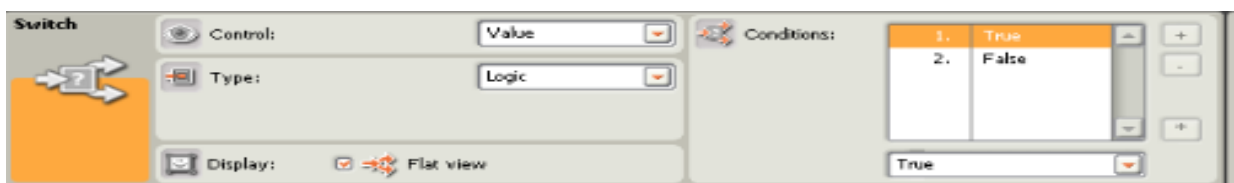
- The third motor block:
  - Port: A
  - Direction: Forward
  - Duration: 90 degree
  - Power: 75



- The Compare Block:  
→ Operation: Less than



- The Switch Block:  
→ Control: Value  
→ Type: Logic  
→ Display: Flat View checked



- The upper move block:  
→ Port: B & C  
→ Direction: Forward  
→ Steering: Full Steering toward B  
→ Power: 100  
→ Duration: 200 Degree



- The lower move block:  
→ Port: B & C  
→ Direction: Forward  
→ Steering: Full Steering toward C  
→ Power: 100  
→ Duration: 200 Degree





8. Download and run your program.
9. Place an obstacle to the right side of the robot. Observe the direction of the turn? \_\_\_\_\_
10. Place an obstacle to the left side of the robot. Observe the direction of the turn? \_\_\_\_\_

**Note: if the robot turns toward the obstacle direction, swap the connection for motors B and C.**

#### Questions:

- Suggest an application of the previous explorer code.  
\_\_\_\_\_
- How can you modify the previous program to display the ultrasonic readings from both sides on the NXT Screen?  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

- Explain the sequence of the NXT-G code shown in Figure 1.9.

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_
4. \_\_\_\_\_
5. \_\_\_\_\_
6. \_\_\_\_\_
7. \_\_\_\_\_
8. \_\_\_\_\_

- **Identify the programming blocks that are used in Figure 1.5**

Programmming Block Name	Function	Programming Palette

## 1.7 Review Exercise

1. In a certain robot application, the programmer used the following configuration for the given block. Fill the missing information for each block.

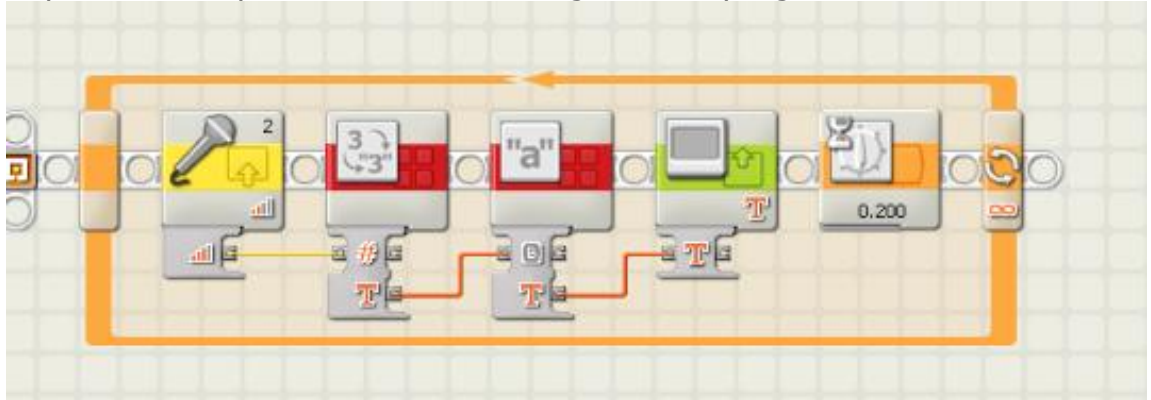
- The block shown is a \_\_\_\_\_
- The block can be found under \_\_\_\_\_ palette.
- The block is used to \_\_\_\_\_



- The block shown is a \_\_\_\_\_
- The block can be found under \_\_\_\_\_ palette.
- The block is used to \_\_\_\_\_
- Compare Operation is: \_\_\_\_\_



2. Explain the sequence of the following NXT-G program:



1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_
4. \_\_\_\_\_
5. \_\_\_\_\_
6. \_\_\_\_\_

### References:

- Terry Griffin (2010). *The Art of LEGO MINDSTORMS NXT –G Programming*. No starch press: USA
- Kelly,F,G. (2007). *LEGO MINDSTORMS NXT –G Programming Guide*. Apress:USA

### Appendix 1: Explorer Robot Building Guide



